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Effect of *Zinnia Elegans* as a mix-crop along with tomato against *Meloidogyne Incognita* and *Rotylenchulus Reniformis*

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1 Introduction

Root-knot and reniform nematodes have been recognized as the major limiting factor in agricultural production in many parts of the world. The use of nematicides for the management of nematodes is being discouraged because of their polluting effects, and they present health hazards to human and animals. Also, excessive use of nematicides causes environmental risks and could lead to the development of resistance in target species. An alternative control measure may be obtained by the use of antagonistic plants (KHAN et al., 1971; ALAM et al., 1977; SARTAJ et al., 1986 and KORAYEM & OSMAN, 1992).

Zinnia plants have been found to suppress the population of phytonematodes by releasing nematotoxins into the soil when grown with susceptible crops and/or their extracts used (PANT et al., 1983; RAFIG et al., 1985; MEHAR B. et al., 1986 and SARTAJ et al. , 1986). The present investigation was undertaken to study the effect of different numbers of *zinnia* plants as a mixed-crop along with tomato for control of rootknot and reniform nematodes under greenhouse conditions.

2 Materials and Methods

Three week old seedlings of tomato (*Lycopersicom esculentum* Mill.) cv. Ace grown in sterilized soil were transplanted singly to the center of 15 cm. clay pots containing 1 kg sterilized sandy loam soil. One week after planting, the tomato seedlings were inoculated with about 3000 freshly hatched juveniles of the root knot nematode, *Meloidogyne incognita* (KOFOID & WHITE. 1919) Chitwood, 1949, or 3000 unswollen females of reniform nematode, *Rotylenchulus reniformis* Linford & Oliveira, 1940. Three days after inoculation, one to four seedlings of 20 days old *Zinnia elegans* Jacq grown in sterilized soil were transplanted into the periphery of each pot. Tomato seedlings planted without *zinnia* plants served as a control group.

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Each treatment was replicated four times. Then all the pots were arranged in a randomised complete block design under greenhouses at 30 ± 5° C. Fifty days after inoculation, plants were taken out and nematode counts were calculated. Nematode populations in the soil were determined by means of centrifugal flotation technique (Jenkins, 1964). Root-knot index was rated 0 - 5 scale of SASSER et al., 1984. The obtained data were analyzed statistically by using the Fisher's Least Significant Differences (L.S.D.).

3 Results and Discussion

Table 1: Effect of *Zinnia elegans* as a mix-crop with tomato cv. Ace on *Meloidogyne incognita*

Treatments	Root-gall Index[1] (0-5)	Reduction (%)	Nematode counts[2]				Rate of build-up[3]
			In root	In soil	Total	Reduction (%)	
Tomato alone (control)	4.0	-	193	16062	16255	-	5.4
Tomato + one plant of zinnia	2.7	32.5	93	3930	4023	75.0	1.3
Tomato + two plants of zinnia	1.7	57.5	62	2400	2462	84.8	0.8
Tomato + three plants of zinnia	1.2	70.0	40	2003	2043	87.4	0.7
Tomato + four plants of zinnia	0.7	82.5	17	1789	1806	88.8	0.6
$L.S.D._{0.05}$	0.219	-	28.8	613.3	616.8		
$L.S.D._{0.01}$	0.340	-	39.9	848.1	852.9		

Data presented in tables (1 & 2) showed that *zinnia* plants were found to suppress *M. incognita* and *R. reniformis* reproduction. The tested zinnia plants showed a significantly reduced number of nematodes on their roots, number of juveniles recorded from their soil as well as their root gall index. Consequently, the final

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1 Root gall index: 0 = no galls; 5 = 100^{+} gall per root (Sasser et al., 1984).

2 Each value is mean of four replicates

3 Rate of build-up $\frac{P_f}{P_i}$, where P_f = final population, and P_i = initial population

nematode populations and rate of build up were greatly suppressed. It is also interesting to notice that there was a positive correlation between number of *zinnia* plants and reduction in nematode final population of both nematodes as well as the reduction in root gall index caused by the root-knot nematode. Therefore, treatment with 4 plants of *zinnia* caused the greatest reduction in the root gall index (82.5 %). On the other hand, there was a negative relation between the number of *zinnia* plants and nematode final populations of the root-knot and reniform nematodes as well as their rate of build-up.

Table 2: Effect of *Zinnia elegans* as a mix-crop with tomato cv. Ace on *Rotylenchulus reniformis*

Treatments	**Nematode counts**[4]				**Rate of build-up**[5]
	In root	**In soil**	**Total**	**Reduction (%)**	
Tomato alone (control)	155	4891	5046	-	1.70
Tomato + one plant of zinnia	60	2046	2106	58.3	0.70
Tomato + two plants of zinnia	47	1325	1372	72.8	0.46
Tomato + three plants of zinnia	19	927	946	81.3	0.32
Tomato + four plants of zinnia	17	811	828	83.6	0.28
$L.S.D._{0,05}$	12.9	231.2	324.4		
$L.S.D._{0,01}$	17.9	319.7	448.6		

In general, we state that there was a significant increase in the final nematode population and rate of build-up of *M. incognita* around tomato grown alone, however, in pots having different numbers of *zinnia elegans* (1 - 4 plants/pot) with tomato, the nematode final population and rate of build-up was less. The root gall index on tomato was 4 when it was grown alone, but decreased to 0.7 when tomato was grown along with 4 plants of zinnia.

Similarly in the case of *R. reniformis*, the final nematode population and rate of build-up decreased sharply when tomato was grown along with different numbers of *zinnia* compared to tomato grown alone. These data indicate that the decrease in the nematode

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4 Each value is a mean of four replicates

5 Rate of build-up = $\frac{P_f}{P_i}$, where P_f = final population and P_i = initial population

final population and rate of build-up by growing *zinnia elegans* is mainly attributable to the toxic nature of its root-exudate. These findings conform with those of ALAM et al., 1977; SARTAJ et al., 1986 and KORAYEM & OSMAN, 1992. They reported that there are several plants which suppress the population of plant parasitic nematodes by releasing nematotoxins into the soil.

Types of resistance to root-knot nematode were reported by FASSULIOTIS (1979). He indicated that there are two types of resistance. The first is the preinfectional resistance, which operates before the nematode penetrates the surface of the roots. The second is the postinfectional resistance which is manifested after the nematode penetrates the plant tissues. Data obtained in this work indicated that *zinnia* plants have two types of resistance in that most of *M. incognita* and *R. reniformis* larva failed to penetrate roots of tomato when they were grown with *zinnia* plants. Moreover, PANT et al. (1983) have demonstrated that *M. incognita* did not multiply on *zinnia elegans*. Present findings suggest the potential importance of developing plant-based natural nematicides for nematode control.

4 Summary

The nematicidal potential of *Zinnia elegans* Jacq (1,2,3 & 4 plants per pot) as a mixed crop along with tomato against *Meloidogyne incognita* and *Rotylenchulus reniformis* was studied under greenhouse conditions. The final population of both nematodes and their rate of build up as well as the root gall index were significantly affected by the number of *zinnia* plants when grown with tomato together. There was a negative correlation between the number of *zinnia* seedlings and the final population of both nematodes. The lowest nematode final population and rate of build up were determined at the highest number of *zinnia* plants (4 plants per pot). The highest number of root gall index was found on roots of tomato grown alone (4), while, the lowest one was found on roots of tomato (0.7) grown with four plants of zinnia. This type of control is considered inexpensive and pollution-free.

Einfluß von Zinnia elegans als Mischfrucht mit Tomaten gegen Meloidogyne incognita und Rotylenchulus reniformis

Unter Gewächshausbedingungen wurde das nematizide Potential von Zinnia elegans im Mischanbau (1-4 Pflanzen / Topf) mit Tomaten gegen M. incognita und R. reniformis untersucht. Die Nematodenendpopulation, die Bildungsrate sowie der Wurzelgallenindex wurden an Tomaten im Gemisch mit Zinnia signifikant beeinflußt. Zwischen der Anzahl der Zinnia-Sämlinge und der Population beider Nematodenarten zu Versuchsende lag eine negative Korrelation vor. Mit zunehmender Anzahl an Zinnia-Pflanzen (4 Pflanzen/Topf) ging die Nematodenendpopulation und die Bildungsrate zunehmend zurück. Der höchste Wurzelgallenindex wurde an separat

kultivierten Tomaten festgestellt. Diese Form der Regulierung von Nematoden ist nicht nur billig sondern auch schadstofffrei.

Influencia de Zinnia elegans como cultivo de mezcla con tomates contra Meloidogyne incognita y Rotylenchulus reniformis

Bajo condiciones de invernadero se investigó el potencial nematicida de Zinnia elegans en cultivo mezclado (1 - 4 plantas por maceta) con tomates contra M. incognita y R. reniformis. La población de nematodos, la cuota de formación como también el indice de tumores radiculares fueron influenciados en forma significante en los tomates plantados en mezcla con Zinnia.

Entre la cantidad de semillas de Zinnia y la población de ambas especies de nematodos se comprobó al finalizar el experimento, una correlación negativa. Con una creciente cantidad de plantas de Zinnia (4 plantas por maceta) disminuyó la población de nematodos y la cuota de formación en forma considerable. El mayor indice de tumores radiculares fué regitrado en tomates cultivados por separado. Esta forma de regulación de nematodos no es solamente económica sino también libre de sustancias nocivas.

5 References

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